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Experimental access to higher-dimensional discrete quantum systems, towards realizing SIC-POVM and MUB measurements, using integrated optics[1]

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The aim of our work is to access and explore higher-dimensional photonic quantum systems. In terms of stability and complexity, normal bulk-optic setups greatly limit the capabilities of reaching higher-dimensional systems. However, the recent development in integrated photonic circuits has opened new possibilities [1]. Our approach is to use integrated photonic circuits on-chip, as well as in fiber, to reach photonic states of higher dimension. We are working toward a fully integrated realization of a multiport [2], a device which can apply any unitary transformation based on tunable internal parameters. Our first step is to realize a multiport in dimension four, implementing any unitary transformation on Qubits, Qutrits and Ququarts. Furthermore, we have built an integrated source using purely in-fiber components for creating higher-dimensional entangled photons. The combination of this source with the multiport yields a very general system applicable to a variety of experiments in higher dimensional Hilbert spaces. It is possible to realize different experimental setups by setting the device for different incoming entangled states, and subsequently applying unitary transformations. For example, this opens the possibility to observe new types of higher-order perfect correlations [3], or to realize full SIC-POVM measurements in higher dimensions.

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[2] M.Reck and A.Zeilinger, PRL Vol.73, No.1 (1994)
[3] M.Zukowski, A.Zeilinger and M.A.Horne, PRA Vol.55, No.1 (1997)

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